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GRAIN SUPPLY IN TWO WARS: THE NAPOLEONIC AND THE EUROPEAN.

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At the heart of all the controversial writing about our agriculture lies the question of the arable acreage; and not only does this question concern our agriculture, it concerns the agriculture of most of the countries of the world. Everywhere, by what has been generically termed rationalisation, the yield per acre is increasing while the man-power required grows steadily less. Consequently the net output per unit of land and per unit of labour is increasing, and the position of over-production in the staple food-stuffs is reached at least temporarily. The market has declined and the farmer finds it impossible to obtain a price which covers his cost of production. The solution of this difficult position presents apparently insuperable obstacles, but it is not the purpose here to discuss that part of the question.

The possibility of making England self-supporting in cereal supplies has been canvassed from several angles. We are in the throes of a discussion of the avoidance of war in the future, but our efforts to this end may not be successful, however much we may hope that men of good-will will be able to achieve it. And when we remember that at one time during the last war our margin of cereal stocks was perilously low, it is necessary for us to consider, whether and how it would be possible to extend the area under corn so as to remove this dangerous possibility in the event of any future altercation between the nations of the world, and the experiences of the last two great wars of the modern civilisation are not unhelpful in this connection.

Although there was a succession of minor wars during the nineteenth century these were not of sufficient dimensions to place the food supply of the countries involved in jeopardy. At the extremes of the century the wars with France and the war with Germany did have this effect, and it is from these wars that we can perhaps learn a useful lesson (*1*).

Turning to the first we find that in the Napoleonic era the importation of grain was a new development in our national life, and, before the period of the wars, had been intermittent and comparatively slight. The period of transition, when England ceased to be predominantly a grain exporting and became a grain importing country is indicated by the following table (*2*):

1 Mr. Fussell is engaged in historical research in agriculture in England. Note that "corn" should be read to mean wheat, oats, barley and rye, and that a "quarter" of grain is 8 bushels or approximately a quarter of a ton. Editor.

		WHEAT (BUSHELS)
1760 (1757-66)	Export	1,808,032 (average of 10 years).
1770 (1767-76)	Import	1,061,584
1780 (1777-86)	"	1,200,560
1790 (1787-96)	"	1,620,224
1800 (1796-05)	"	4,899,272

The evidence of this in this table is sufficiently corroborated by the following figures in which the decennial period used is not quite the same, but which leads to the same conclusion as that of the majority of writers on the subject (*3*):

	CORN	
	EXPORT QUARTERS	IMPORT QUARTERS
1770 (1765-74)	510,000	1,341,000
1780 (1775-84)	1,366,100	1,972,000
1790 (1785-94)	1,305,385	2,015,000
1800 (1795-04)	536,000	6,686,000
1810 (1805-14)	593,000*	5,782,000

* 9 years only.

The main source of supply was the Continent of Europe, although from 1800 onwards quantities of grain and flour of no mean dimensions were imported from America, but, when the harvest failed in England, it was to the customary Continental sources of supply that the Government was forced to turn. In the late War, with the exception of Russia and Rumania before 1917, Europe did not contribute to the supply of food stuffs for this Country and its Allies. The imports were obtained from the United States, Canada and the Argentine, while supplies from Australia became increasingly difficult to transport as the War progressed.

Before 1800 there was no certain basis for estimating any of the factors, which should govern the restriction of importation, or its extension, or indicate the necessity for increasing the tillage area at home. The number of the population was not then certainly known. The acreage devoted to tillage was a subject of controversy. The amount of food stuffs produced was obviously impossible to ascertain, and the lack of scientific knowledge regarding the essentials of human dietetics made it impossible for the Government of the day to estimate their total requirements. In 1914 all this essential knowledge was practically and readily accessible, so that, in spite of the fact that the population was nearly four times as large (1811, 10 million; 1911, 36 million, E. & W.), it was possible to make provision, in theory at any rate, for the production and importation of a sufficient quantity of food.

That is one marked point of dissimilarity between the two periods. Another was the proportion of the annual supply of grain grown in the country. Statisticians of the Napoleonic wars estimated that, even in the bad harvests which were so frequent then, the home production was equivalent to at least 42 weeks supply. While these figures can hardly be substantiated, it is significant that the position was almost reversed in the

20th century. The supply of cereal food stuffs therefore turned very much more upon facilities for importation during the last war than it did a hundred years ago, although the necessities of that time occasionally demanded the importation of nearly a million and a half quarters of grain annually.

It is difficult to decide the precise relation that this quantity bore to the total consumption and thus to the home production, but two estimates perhaps a little more definite than the time measure given above, which are tentatively accepted by Professor Galpin will give an indication of these proportions. In 1800 a Parliamentary Committee estimated that the home production of wheat was 6,700,000 quarters: in 1810, Arthur Young, giving evidence before another Parliamentary Committee, estimated the annual consumption of wheat at 8,500,000 quarters. The maximum imports during this period were above 1½ million quarters in one year. If these figures are accepted, the maximum ratio between imports and home production is therefore between 1.5: 8.2 and 1.5: 8.5 which gives no very large variation. Of course it should be remembered that the imports rose and fell in accordance with the abundance of the harvest. But an elementary comparison between the two periods is afforded by the statement of the Wheat Commission that the average cereal importation of the United Kingdom was ten million tons in the early years of the 19th century.

This quantity, in itself larger than the total consumption of the earlier era, is explained by the rapid growth of the population in the 19th century. In the hundred years between 1811 and 1911 the numbers of the people had almost quadrupled, and it is not surprising therefore to find the demand for bread-corn so largely increased, particularly in the matter of importation.

The constantly fluctuating conditions of war influenced the policy of the moment in both wars, and the changing conditions of the harvest, both at home and abroad, made rapid alterations of policy necessary to meet the demands of the changing situation; but the public was never intimidated by the fear of starvation in the 20th century as it was in the 19th.

The succession of bad harvests of the Napoleonic wars caused grave misgiving in 1795 and 1796, in 1799 and 1800 and again and again during the last fourteen years of the wars when the complete ignorance of their real circumstances led many phampleteers and journalists to flood the country with a mass of "scare-head" literature, which not only terrified the people, but caused some consternation amongst members of the Government.

The situation then did not, however, demand such drastic measures as in the later war. The high price of wheat was thought a sufficient stimulus for encouraging the farming community to exercise its utmost capacity for producing more cereals, and the deficiencies of the recurrent poor harvests were supplied by importation. The justice of this attitude is shown by the constant endeavours of private individuals to enclose waste land and bring it under tillage cultivation, whereby the home production of grain was undoubtedly increased in quantity, although it is probable

that the average yield per acre over the country was in some degree (possibly of the order of about 2 bushels an acre) reduced (*4*).

This mechanical control of the cultivation by the incentive of high price was good enough for the comparatively small problems of the Napoleonic era: but when the much larger problem of the 20th century confronted the Government it was essential that some co-ordinated organisation for the purpose should be set up.

In the Napoleonic era no attempt was made to ration the consumption of bread-stuffs: the price of the loaf was a sufficient guarantee that the workers would not consume any excess, and when the harvest was short Royal Proclamations were issued requesting people of a more wealthy class to confine their consumption of bread to the first meal of the day and to cases of sickness, while restrictions were placed upon distillation and upon the manufacture of hair powder and starch. No doubt some economy of consumption was effected by these measures, as by the constant agitation for a less finely milled flour, but of what order this economy may have been, it is now almost impossible to say.

The measures taken to supply the deficiencies of the harvests of this time are more easily discernable, and Professor Galpin (*5*) has given us a close study of them. It may suffice to give a few brief details here.

The importance of imported supplies even so long as a century ago may be indicated by Galpin's belief that the condition of the country, after the poor harvests of 1799 and 1800, was one of the most important factors in bringing about the peace of Amiens. "A shortage in the home production", he says, "riots of a frequent and serious nature, a stoppage of the foreign supply and an era of high prices had argued constantly for peace".

During the years 1800, 1801 and 1803 increasing imports were obtained from America. For instance in 1801 nearly a quarter of a million quarters of wheat (about one-sixth of the maximum imports of the time or approximately one-thirty-second of the assumed annual consumption) (*6*) were shipped to England under license, although the trade stagnated under the Peace in 1802 in spite of the bountiful American harvest of that year. The outbreak of war again stimulated it and practically one-fourth of the total wheat imported in 1803 came from the United States. This trade continued till 1807, but it declined under the difficulties created by the Berlin Decree and the friction between America and England which ultimately led to war in 1812. Intermittently, and legally or illegally, a good deal of wheat reached England from America during these years, the quantity being 170,939 quarters in 1809.

Meanwhile the growing power of Napoleon had restricted the trade with the Continent: this restriction, of course, affected the different countries in varying degrees as the war progressed. By 1803 the French dominance of Prussia had effectually curtailed the export of corn from that country to England, and, although some exports continued to be sent, Napoleon, after the brief conflict with and victory over that State, was able to control the supplies of nearly the whole of Germany. The conditions

were not, however, entirely adverse to this country because there was some illicit trade connived at by the French officials who were open to bribery.

In Holland Napoleon was more successful, and the effect of his measures was that practically no corn was received up to 1806. Small supplies were obtained from Scandinavia during this period. The effect of the Berlin decree was very marked upon Prussian supplies, but, even after Napoleon's brother Louis became King of Holland, there was a large trade with England amounting to approximately 240,000 quarters in 1807.

What seems to us a curious anomaly of the Napoleonic wars arose two years later. It is unusual for two nations at war to trade with one another, especially when each has endeavoured to blockade the other: but in spite of the widespread area of the war, physical conditions made it necessary for the blockade to be mutually relaxed in 1809. Heavy harvests in France, which naturally involved low prices, poor harvests in England combined with some stoppage of the foreign trade causing high prices, led to a trade between the two countries. There were, of course, other reasons for this official relaxation of the blockade. For one thing it was impossible with the means to hand in the early 19th century to blockade a continent effectually. The capacity of sailing ships is limited. They depend upon wind and weather and their speed is slower than that of mechanically propelled vessels. It is true that a fleet could patrol a port, but it could not effectually patrol a coastline of hundreds of miles. Failure was self-evident, but beyond that, Napoleon had an urgent need for British woollens, cottons and hardware, and in order to carry on the war with Britain he was forced to trade with that country either officially or through the smugglers. The surplus of corn in France supplied him with an excuse as well as an additional reason for licencing a trade with his enemies.

In the first year of this arrangement the trade was meagre; but large supplies were obtained from Holland, and in 1810 over 225,000 quarters of wheat were sent from France to England, (about as much came from Holland), although the harvest of that year in France proved to be below average. Similar conditions in 1811 and 1812 forbade this trade to be extensive. France was poverty-stricken for corn and could not export, but would undoubtedly have done so had she possessed the supplies.

A large part of the balance of the imports required in these years was obtained from Prussia where the failure of the restrictions and the harvest conditions enabled exports to be made, while Germany also played her part in the trade as conditions allowed. As occasion and opportunity demanded supplies were obtained, and it has been shown by Professor Galpin that this trade was not the determining factor in the conduct of the war. Although it is, as he admits, impossible to decide, except from indirect evidence, which is being examined by the present writer, exactly what was the volume of home production or how much it was developed during the wars, there is little reason to believe that this country would have starved if the Continental System had been completely effective.

In order to show that the home production had increased Professor Galpin accepts with but slight reserve the comparative figures to be found in "Tracts on the Corn Trade" 1759 and Arthur Young's later estimate (7)

based upon the proportionate number of the increased population who ate the different kinds of corn. This is perhaps sufficient evidence for his purpose, but the bases of calculation in the "Tracts" are a little dubious, although a fair comparison may possibly be claimed because the same bases are used in Young's estimate of the consumption. There is no doubt that there was some increase in home production, but it may not prove upon closer examination of the scanty evidence to be so large as Professor Galpin indicates. However that may be, the population was fed during the Napoleonic wars, and his book supplies a carefully drawn picture of the methods of trade whereby the balance over the home production was obtained.

The problem of providing grain in sufficient quantities to feed the people during the European War was of much larger dimensions than that of the Napoleonic War, but it was the same in kind although so very different in degree: and in spite of its size it was rendered more susceptible to regulation and administration by the much greater and more accurate knowledge possessed by those who had to legislate for it. Organisation was imperative and it was developed as the war progressed. The mechanical control of price, while sufficiently efficacious in the Napoleonic Wars, would have been ineffective in the circumstances of the later period: indeed price itself had to be placed under control in order that the organisation might be effective.

Not only had the population increased nearly four times in the century between the end of the earlier struggle and the beginning of the later, but the actual conditions under which the country's food supply was obtained were almost exactly opposite to what they had been. Whereas, as we have seen, only a small proportion of the cereal food of the Nation was imported in the early 19th century, for practical purposes only about the small proportion formerly imported was produced at home in the early 20th century.

In these circumstances it was obvious that some definite steps must be taken to increase the proportion of home produced supplies, and it was all to the good that at the outbreak of hostilities there was in existence an official department (then the Board of Agriculture) which had accumulated twenty-five years experience of the agricultural industry. During the Napoleonic wars there was, of course, no really comparable department, the Board of Agriculture of that date, which had only been formed in 1793, being a private body receiving a grant of £3,000 a year from public funds, and possessing only the exiguous powers which the industry chose to allow it to exercise.

At first the President of the Board of Agriculture received no special powers, and the Consultative Committee on Agriculture, formed in the early days of the late war, could do little more than propaganda work somewhat similar in kind to the Royal Proclamations of the famine years of the Napoleonic period. Its results were considered not unsatisfactory but the position remained sufficiently difficult for the government to desire a more definite organisation of the national resources. The Production of Food Committees appointed early in 1915, reported by the autumn, and

thereafter the County War Agricultural Committees were established with the main purpose of increasing the area under cereals to that of the seventies of last century, but weather conditions during the sowing time for the 1916 harvest were bad, labour difficulties were continuous in spite of all that could be done to ameliorate them, and *in fine*, it was found that the area under cereals had actually decreased during the year. This was due to a variety of causes, which have been elaborately examined by Sir Thomas Middleton, (*8*) and which cannot be entered upon here. It is sufficient to say that in the United Kingdom the three cereals yielded 261,000 tons less than the average pre-war crop.

More drastic measures then became necessary. The Food Production Department was accordingly set up on the 1st January 1917. A rapid survey of the whole country was made, and so far as possible it was at once determined what land should be ploughed for corn.

The enemy's policy of unrestricted submarine warfare which began on the 1st February, 1917, was far more effective than any attempt towards effective blockade could have been in the Napoleonic period, and speedily showed how important the Department's work was to become. The supply of labour, manure and seeds presented almost insuperable difficulties, but, if these difficulties could not be entirely overcome, they were at least rendered less formidable. In spite of bad weather both at sowing and harvest in addition to the other difficulties the area under corn was increased by some 286,000 acreas in England and Wales, while the United Kingdom showed the remarkable increase of 975,000 acres above 1916 (chiefly contributed by Ireland).

This result was achieved almost incidentally to the plans and programmes for the 1918 campaign formulated in the beginning of March 1917. For that year it was decided to attempt a very large addition to the tillage area under pressure of a national organisation instead of allowing the impetus of high prices to effect it, as in the former European struggle. Each County was once more surveyed and the land selected for ploughing.

When the results of all the efforts made came to be summed up it was found that the area of tillage cultivation had been increased by nearly 2,000,000 acres in England and Wales and the increase of the crops in the United Kingdom in 1918 above the pre-war average was represented by a million tons of wheat, a million and a half of oats, and 2½ million tons of potatoes.

The production of grain and the cultivation of potatoes is not, of course, the complete story, but Sir Thomas Middleton is satisfied that the total effort made had increased the supply of home-grown food, including livestock, above the pre-war standard by an equivalent of 30 days supply for the nation living its normal life. In other words the quantity grown in 1918 would suffice for 155 days of the year; before the war it would have fed the nation for 125 days only.

Commendable as this increase was, it is clear that the country would have starved if imports had been substantially reduced, whereas it seems equally clear that by measures of economy the country could have sub-

sisted without imports in the Napoleonic Wars. In these circumstances the importation was of even greater consequence from 1914-1918 than it was from 1793-1814. Realisation of these circumstances led to the appointment of the Royal Commission on Wheat Supplies by Royal Warrant on the 10th October 1916, and it dealt with the questions involved in the control of importation, the stimulus of colonial and foreign efforts to increase production and the distribution of the produce to the millers etc.

Such was the organisation adopted to deal with the importation of grain and flour during the European War, and its efficiency is determined by the fact that it did not become necessary to ration bread any more than it was necessary to adopt that expedient in the Napoleonic era; there was no outcry of starvation and the workers were cared for, whereas there were excellent grounds for the constant complaints on both grounds in the earlier period.

Not only was this organisation more effective than the earlier method of trusting to private enterprise might have been, but it was, of course, able to work with greater facility owing to the larger measure of knowledge possessed.

The pious hopes, supported by Royal Proclamation of the necessity for frugality in eating bread, the many declarations that a higher degree of flour extraction should be made in the Napoleonic era, were paralleled in the recent war by an organisation for the control of flour mills. It would have been insufficient to control home production and importation without this measure. High extraction and dilution were both employed to conserve the supplies of grain. All the other grains were used with varying degrees of success, and potatoes, that succedaneum of the Napoleonic period, were successfully introduced as a diluent.

The industries in which large quantities of cereals were used were carefully scrutinised, and it was found necessary to ration horses in such a manner as to amount, with some exceptions, to a practical prohibition of feeding horses with cereal foodstuffs. These measures had been suggested in the earlier period, but, with the exception of the restriction of distillation and the manufacture of hair powder, were not then adopted.

Perhaps in addition to the much larger dimensions of the work involved, the most marked difference between the measures taken to supply the nation with bread in the two wars is that of control in the later, and the curiosity of licensed trading with the enemy in the earlier time. Although most of the measures adopted in the 20th century were suggested in the late 18th and early 19th they were not adopted: exhortation alone was used and the problem was more or less allowed to solve itself. Control was the guiding star of the later war, and propaganda was used only to explain the necessity for control and for the measures taken.

The results of both methods would seem to lead to the conclusion that only in exceptional or controlled circumstances does it become possible to extend in any measurable degree the tillage area in this country. Owing to the great rise in prices due to uncontrolled economic influences the farmer was able to reimburse himself handsomely for an uneconomic process during

the Napoleonic wars, but prices reached so high a level as to become almost prohibitive to a large proportion of the people, and in the worst periods deaths from starvation actually occurred. Control of price and rationing secured the people from any such suffering during the recent war, but the farmer was reimbursed for once again working uneconomically by Government grants and other assistance in respect of the additional area ploughed up.

BIBLIOGRAPHY

1. a. The Grain Supply of England during the Napoleonic Period: W. Freeman Galpin. Macmillan & Co., 1925.
   b. Food Production in War: T. H. Middleton. Oxford University Press, 1923.
   c. First Report of the Royal Commission on Food Supplies 1921. (Cmd. 1544).
   d. Second Report of the Royal Commission on Food Supplies 1925. (Cmd. 2462).
   e. Report of the Director General of Food Production (E & W.) to 1st June, 1918.
2. These figures have been compiled from the numerous Parliamentary Papers issued during the Napoleonic war and later, and from contemporary tracts professing to reproduce figures collected for a House of Lords Committee.
3. These figures are taken from Ernle, English Farming Past and Present, 1922 Ed. p. 266 footnote 2.
4. Craigie. Statistics of Agricultural Production 1883, citing Young 1773, 23 b. an acre and McCulloch 1800-16, 21 b. an acre.
5. op. cit. 2 above.
6. See Parliamentary Papers. First Series. Vol. IX. Various Reports.
7. Parliamentary Papers. Sess. 1812-13, Vol. III. Report from the Select Committee on petitions relating to the Corn Laws.
8. op. cit. 1. b. above.

THE SUGAR BEET NEMATODE, *HETERODERA SCHACHTII*,— A NEW PARASITE IN CANADA

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Canada, according to the latest estimates, is producing in 1931, 90,096,600 pounds of sugar from beets. Only two districts in Canada are involved in sugar beet culture at present, a district near Raymond, Alberta, and one in South Western Ontario, centering around Chatham and Wallaceburg. The Alberta industry began operations in 1924, but the one in Ontario started in 1902 and produces over three-fourths of the Canadian beet sugar. Owing to the comparative newness of this industry in Canada, the problems of disease and insect pests have not played as large a part as in the older beet growing districts of Western United States and Europe. The United States sugar beet industry has been in existence for more than 50 years, as is evidenced by the report of a factory at Alvarado, California, built in 1870 and still operating in 1920 (*1*).

The sugar beet nematode has been known for a quarter of a century in Europe and United States but no record of its presence in Canada is found prior to August, 1931. Technical agriculturists in Canada may be interested in a brief description of the Nematode types and in a report of this first infection of Canadian sugar beets by a Nematode. The importance of this parasite is realized when it is known that the sugar beet industry in Canada involves annually some 40,000 acres of the best crop land and returns several million dollars to the farmers and field laborers who handle the crop under contract with the manufacturing companies.

Among the round worms (*phylum Nemathelminthes*), the most important group is the Nematoda. These small round worms, most of them barely visible to the naked eye, include both parasitic and saprophytic forms and are found in almost every type of soil, plant and higher animal. Some forms live in the intestinal tract of vertebrate animals and cause "Hookworm", "Ascaris", "Trichuris" and "Filaria" infections. In some cases the parasitic forms have a free-living stage in the soil or faeces. These may be ingested with unclean food or may infect through the skin which comes into contact with soil containing the infective form. The types parasitic on plants usually penetrate the epidermis, suck the plant juices and thereby reduce the vitality of the plant or, by injury to the tissues, allow secondary infections to occur.

A satisfactory general grouping of the Nematode types is given by Waksman (*2*) dividing them into 5 groups, on the basis of feeding habits, as follows:—

(1) Feeding on partly decayed organic matter, bacteria, fungi and algae, e.g. Rhabditis, Diplogaster, Cephalobus, Monohystra.

[1] Dr. Brown is in charge of the Research Department of the Canada and Dominion Sugar Company which has its headquarters at Chatham, Ontario. He formerly held the position of Associate Professor, as head of the Department of Biology in the West China University at Chengtu, China.

(2) Feeding on the tissues of the healthy plants and injurious to them, e.g. Tylenchus, Heterodera, Aphelenchus.

(3) Parasitic on both plants and animals, e.g. Dorylaimus.

(4) Parasitic on animals, especially invertebrate forms, e.g. Necator, Ascaris, Filaria.

(5) Carnivorous and predatory, feeding on other Nematodes, e.g. Ironus, Tripla, Monochus.

Group 2 includes the genus "Heterodera" of which the sugar beet nematode *Heterodera schachtii,* Schmidt, is a member.

Sugar-beet nematodes are economically important in any infected area owing to their rapid increase to enormous numbers. Once introduced into an area, it is almost impossible to exterminate them. The area, once local, is enlarged and Shaw (*3*) reports that the young nematodes can extend the area as much as 50-75 feet each season. Probably the natural migration is only a few feet per year but the infections are often spread by artificial means. Farm implements, such as cultivators, discs and harrows, move particles of soil, containing the nematodes, from infested areas to other parts of the field. Livestock tramping over a recently harvested field, that is in a wet condition, may carry larvae and cysts on their feet. The movements of irrigation or drainage waters is another important agency in the spread of nematodes. In districts where irrigation is practised on beet fields, the spread of infection is likely to be quicker than in the non-irrigated sugar beet areas of Ontario.

Though *Heterodera schachtii,* in the adult female stage, is visible to the naked eye on the roots of the beet plant, it is often desirable to isolate the larvae and adult males from the soil. This isolation of nematodes from the soil may be easily accomplished by a modification of the "Baerman" apparatus described by Cort (*4*). It consists of a small wire gauze basket lined with coarse cloth and supported in a glass funnel. The soil sample is placed in the cloth, previously sterilized, and supported by the gauze. The funnel is closed at the bottom by a rubber tube, clamped tight, and water is added until the surface of the soil is just submerged. A piece of ice is then placed on top of the soil to cool the surface. The active nematodes in the saturated soil are washed out of the soil and carried down to the base of the funnel by their specific gravity and the slowly descending current of cooler water. After 24 hours, the water is run off in definite quantities and centrifuged. By this process the nematodes are concentrated in the bottom of a small centrifuge tube and the last few cubic centimetres contain practically all the nematodes of the soil sample. This water containing the nematodes can be transferred to a counting chamber made of a glass slide, ruled in squares, and the counts made. A second sample, run off from the funnel after another 24 hours, accounts for practically all the nematodes of the soil sample. From tests made, it appeared that nearly three-quarters of the nematodes passed into the first sample and almost one-quarter into the second part drawn off. A more complicated method is described by Cobb (*5*) in which frequent stirrings are made and the supernatant liquid is poured off each time. The specimens are satisfactorily preserved by adding to the

small quantity of water containing them, about 10 times the volume of 70 per cent alcohol, to which a drop of glacial acetic acid has been added. This liquid is heated to steaming and quickly poured into the container with the nematodes.

Nematodes occur abundantly in all soils, but especially in greenhouse soils and certain infested fields. An alluvial soil in the United States was found to contain 3,000,000 nematodes to the acre, most of them in the upper 3 inches. Unmanured soils at Rothamstead, England, had 794,000 per acre in the top 6 inches of the soil and 3,600,000 in manured soils. A corn-field in Missouri had 648,000,000 nematodes per acre. In 1928 the writer made a study of certain North China soils and found the following numbers of nematodes.

Nematode population of certain North China soils.

Soil Type	Av. No. per 100 Gms.	No. in top 3 inches of an acre
Drying beds of Night Soils	492	2,337,000,000
Barnyard Soils	1332	5,326,000,000
Well-side Soils	181	859,750,000
Saturated pond or creek Soils	15	71,250,000
Grass and Sod Soils	158	750,500,000
Uncropped Agr. Soils	189	897,750,000
Cropped Soils recently fertilized	1303	6,189,250,000

These nematodes include a number of previously undescribed species together with some of the human infecting types like the hookworm larvae, but they are mainly free-living forms of the saprophytic type. They feed upon decomposing organic matter, as well as upon the bacteria, fungi and algae of the soil.

The typical soil nematode is about a millimeter long, cylindrical in shape and transparent enough to show the internal organs in transmitted light. Nematodes are very active in the soil solution and move by whip-like flexing of the body, in one plane. This motion distinguishes them from other organisms. The shape of the body varies, with the type, from long slender thread-like forms to shorter blunt-ended types. The shape and relative size of the mouth parts are used in classification. The biting-mouth types are grouped on the basis of their biting organs and the pharyngeal cavity forms. The sucking-mouth types are provided with muscle controlled lips, which fasten the nematode to the prey, and a spear which is protrusible from the oral cavity. This spear is hollow so that the juices pass through it, by suction, into the oesophagus. The latter is usually a muscular body with special thickenings called "cardiac swellings" and they are very typical for each form.

The plant parasitic nematodes include many of economic importance, such as the Wheat nematode, *Tylenchus tritici*, the Root Knot nematode, *Caconema radicicola* and the Sugar Beet nematode, *Heterodera schachtii*. According to the available information, *Heterodera schachtii*, in addition to being parasitic on sugar beets, has been found upon several other

agricultural crops and a small number of weeds. The mangels, cabbage, cauliflower, turnip, radish, rape and rutabaga plants are the only cultivated plants reported susceptible to the beet nematode, while a few weeds including the mustards, lamb's quarters, pig weeds, purslane and dock may carry over the infestation.

Figure 1. The young female sugar beet nematode, as seen under the high power of an ordinary microscope. The nematode, 1000-1500 μ in length, is semi-transparent and moves by rapid flexing of the whole body. The right end is the head, from which the spear is protrusible. About one inch from the head end the muscular oesophagus is distinguishable with its rounded cardiac swelling. These muscular bodies control the spear, which is hollow and allows the beet juices to be sucked through it. The intestinal tract is seen as a wavy line bordered by granular matter. The posterior end is to the left and is sharply attenuated in the larval forms.

In the course of its development, the sugar beet nematode passes through four stages, the egg, two larval stages and the adult. The adult female produces from 100-500 eggs. These are colourless and broadly oval or kidney shaped. The eggs are approximately 85 microns (1/300 inch) in length. From these eggs hatch small slender larvae, microscopic in size and these grow to about 1500 microns (1/16 inch) in length.

The larvae are very active thread-like organisms almost transparent and equipped with a strong spear-like organ, protrusible from the oral cavity. It is this spear, operated by strong muscles, which enables the young nematode to pierce the epidermis of the beet root and make entrance into the beet. This spear is hollow and allows the juice to pass into the oesphagus. The first larval skin is cast shortly after the young nematode enters the beet, and the developing larvae feed upon the plant juices. Up to the time of second moulting, there is little difference between the sexes. Both male and female larvae have a sharply attentuated extremity. After the second moulting the sexes have little similarity. The males remain long and slender, increase several times in length, and develop a pair of claspers. After maturity, these males break out of the beet roots and go in search of females. The females, after the second moult, are flask shaped and remain attached to the beet, where they hang by the head end, on the outside of the beet rootlets. At this stage the females are fertilized by the active males and soon develop into lemon shaped bodies. This is the form of the nematode seen in the field and can be easily recognized by the naked eye, as a small milky-white speck adhering to the root fibres. Figure 4 shows a beet with some of these adhering female cysts and figure 2 shows the lemon-shaped female enlarged

about 150 times. The mature female excretes a gelatinous fluid which remains around the posterior end and into this the eggs are deposited. There may be several generations in a season, so the increase in the number of nematodes is very rapid. With the approach of unfavorable weather conditions the females change from white to dark brown colour and are said to be in the "brown cyst stage". This is a preservation form in which the dead body of the female acts as a protecting sac for the eggs which remain dormant over the winter. With the return of favorable weather, most of these eggs hatch, but the eggs may remain for 5 or 6 years in a viable condition. (Thorne *6*).

FIGURE 2

FIGURE 3

Figure 2. The lemon shaped female nematode "*Heterodera schachtii*" attached to a sugar beet rootlet, by the head end. The maturing female swells to this sac-like body, rupturing the rootlet in which the worm has been feeding, but clings to the rootlet until fertilized by the motile male. These females are pearly-white specks about 1/32 inch in diameter and visible to the naked eye. There are often a thousand or more on a single beet. With approaching unfavorable weather conditions they encyst as a brownish sac containing several hundred eggs.

Figure 3. This photograph shows the female of the sugar beet nematode as a cyst which has been crushed under a glass cover-slide. The lemon-shaped female contains 100-500 eggs, averaging 1/300 inch in length. These eggs are seen as elongated ovals or kidney shaped bodies which almost completely fill the body of the female. Normally the eggs pass the winter within the protective cyst, which has a thick wall. They are extruded from the posterior end in a gelatinous fluid and under favorable conditions develop into thread-like larvae, which move about by a flexing of the whole body.

The effect of *Heterodera schachtii* upon the sugar beet becomes apparent in the foliage of the infested plants as the season advances. While looking over some experimental plots on a sugar beet field at Glencoe,

Ontario, in late August, several small patches of wilted beets were noticed. Examination of these beets showed the rootlets infested with many minute pearly-white bodies. A badly infested beet may have over a thousand of these. Examination under the microscope showed them to be the typical cysts of the female sugar-beet nematode and upon crushing one of these cysts, the small kidney shaped eggs were extruded. Figure 3 illustrates this condition and shows the broken female cyst packed with semi-transparent eggs. Some infected beets were sent, through the Dominion Entomological Branch, to the U.S. Department of Agriculture and the diagnosis of *Heterodera schachtii*, Schmidt, was confirmed by Dr. G. Steiner, Senior Nematologist of the Bureau of Plant Industry, Washington.

FIGURE 4

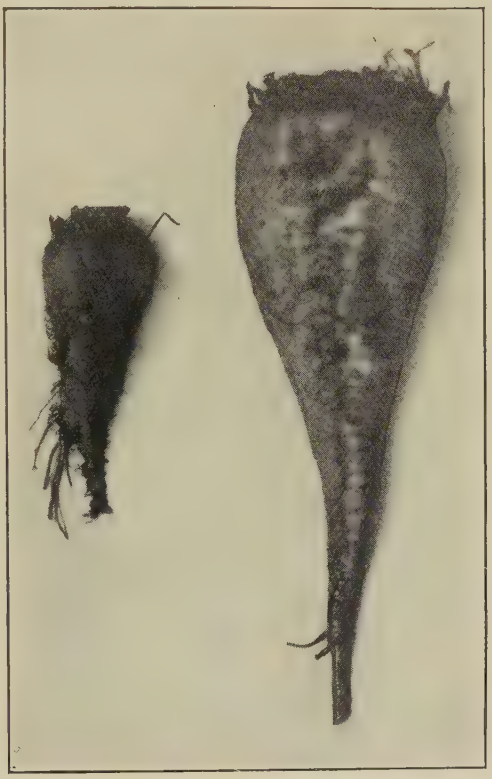

FIGURE 5

Figure 4. Sugar beet infested with *Heterodera schachtii*. The beet has a thin unhealthy appearance and is below average size. The abnormal growth of rootlets is a result of nematode injury. The beet-root has been infested with the speared, suckling-mouthed nematodes which have lowered its vitality and caused it to put forth a mass of rootlets. At the stage when this photograph was taken the females have emerged from the rootlets and are hanging by the head ends. They appear as barely visible, milky-white specks on the rootlets.

Figure 5. The sugar beet on the right is a typical healthy beet, weighing 1½ - 2 lbs. It has a single tapering root and, when mature, is relatively free from fine rootlets. The beet on the left is badly infested with nematodes. It is reduced in size, has forked roots, and the abundant growth of fine rootlets is an attempt on the part of the beet to overcome the nematode injury.

In the heavily infected patches, such as may be seen in the accompanying photograph of a beet field at Glencoe, it was found that the sugar beets were considerably smaller in size and had an abnormal growth of rootlets. It is this characteristic which has caused the diseased beets to be called "whiskered beets" or "bearded beets." The typical wilted condition of the beet-leaves gave rise to the French term "Fatigue des terres cultivées en Betteraves" or the German term "Rubenmudigkeit", "Beet Weariness". Infested beets, besides loss in size, have a lower sugar content. The Great Western Sugar Co., of Colorado, (*7*) report a reduction from 14.9 per cent sugar in healthy beets, to 8.4 per cent sugar in badly infested beets. With continued cropping of an infested soil, the yield is reduced and the sugar content falls below a productive level. Data furnished by U.S. Department of Agriculture, Bulletin 1514 (*8*) shows that a yield of 18.69 tons per acre of beets, the first year after a good rotation, was reduced to 7.4 tons, the next year on the same yield. Such a yield is unprofitable for the grower.

Figure 6. The field of sugar beets at Glencoe, Ontario, where the sugar beet nematode was first found. In the foreground is a patch of beets heavily infested with nematodes. The beets have a wilted appearance with the leaves collapsed. The rest of the beets are fresh looking with more upright leaves. Nematode infestations have been called by the French "Fatigue des terres cultivées en Betteraves".

Fortunately, in Ontario, we seem to have detected the infestation at an early stage. The source of these nematodes is not definitely known, but probably they came to Canada in dirt adhering to sugar-beet seed. The seed used during recent years has been imported chiefly from Germany, Denmark and Czecho-Slovakia. The cysts were probably adhering to the rough surface of the seed balls and thus imported from Europe. The Dominion Entomological Branch sent investigators in the autumn of 1931 to survey the situation throughout the sugar beet growing area of Ontario. After six weeks of survey they have not detected any other infected fields and have taken adequate precautions to prevent spread

from the one reported. The field in question has grown sugar beets almost every second year for the past 15 to 20 years and this fact has considerable bearing upon the present infection.

Rotation is the best known control against the spread of *Heterodera schachtii.* Noticeable infestation of sugar beets is found only in fields which have produced many crops of beets, with little or no rotation. It is, therefore, of the utmost importance to establish a crop rotation system for fields in the beet growing areas. At present we are recommending a four or five year rotation for sugar beets, including at least one sod-forming legume crop. Alfalfa is not known to be attacked by this nematode and its use is highly recommended in the rotation. Sugar beets, when grown in rotation with other crops, are also less susceptible to other diseases such as, Blackroot, Curly Top, etc. The generally grown crops of South Western Ontario, including clover, beans, peas, potatoes, wheat, barley, oats, corn and tomatoes, are suitable crops in the rotation, for the intervening years between crops of sugar beets, so there is little excuse for not practicing a rotation which will insure no spread of this parasite.

Chemical agents have not been successfully used to destroy sugar beet nematodes. It has not been possible to get sufficiently deep penetration of the soil to kill all the individuals. When beets are again planted in the field, the infestation develops. Sulphur, at 400 lbs. per acre, and Calcium Cyanide at 800-1600 lbs. per acre did not produce effective results. The use of decoy plants has been suggested, in which several crops of sugar beet seed or rape seed are sown in rapid succession, and as soon as the nematodes get into the young plants these are harvested and destroyed. Burning the infected plants in straw is probably the most effective method of destroying the nematodes, although heavy liming gives satisfactory results.

During 1931 the one known infected field has been carefully watched and means taken to prevent the spread of nematodes. Infected beets were segrated in piles and heavily limed, under the supervision of the officers of the Division of Field Crop and Garden Insects of the Entomological Branch, Dominion Department of Agriculture. A common source of spreading infection, namely, the hauling and piling of the beets at weigh-stations, was avoided. All beets from the infected field were shipped in carload lots, direct to the factory, and the cars were thoroughly disinfected.

It is hoped, by careful surveys and precautionary measures, to discover any cases of soil infestation by *Heterodera schachtii* at an early stage and by cultural practices, to prevent this pest from spreading in Canada. Without careful attention, the parasite might in time threaten this important agricultural industry.

Summary

1. The sugar beet nematode, *Heterodera schachtii,* Schmidt, has been found in Canada for the first time. The occurrence was reported to the Dominion Entomological Branch in August, 1931, and specimens were sent through to the United States Department of Agriculture at Washington for confirmation of the identification.

2. A brief review of the nematode types is given and some data as to the numbers of nematodes found in soils.

3. The life history of the sugar beet nematode is given, together with micro-photographs of the parasite and illustrations of the damage done to sugar beets by this pest.

4. Methods of preventing the spread of infection are discussed and rotation of crops suggested as the best procedure to be followed.

ACKNOWLEDGEMENT

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LITERATURE CITED

1. TOWNSEND, C. O. The beet sugar industry in the United States in 1920. U.S. Department of Agriculture, Bulletin 995.
2. WAKSMAN, S. A. Principles of soil microbiology p. 347-8.
3. SHAW, H. B. Control of sugar beet nematodes. Bur. Pl. Ind. U.S. Department of Agriculture. Tech. Circ. I. 1918.
4. CORT, W. W. et al Investigations on the control of hookworm disease Part II. The description of an apparatus for isolating infective hookworm larvae from the soil. Am. Jour. Hyg. Vol. II. No. 1 pp. 1-16, 1922.
5. COBB, N. A. Estimating the nema population of soil. Bur. Pl. Ind. U.S. Department of Agriculture. Tech. Circ. 1. 1918.
6. THORNE, G. Length of the dormancy period of the sugar beet nematode in Utah. U.S. Department of Agriculture Circ. 262, 1923.
7. MAXSON, A. C. Principal insect enemies of the sugar beet, in territories served by the Great Western Sugar Co.—published by the Agr. Dept.—The Great Western Sugar Co., Denver, Col., 1920.
8. THORNE, G. Control of sugar beet nematode by crop rotation. U.S. Department of Agriculture. Farmers Bulletin 1514, 1926.

PROVENDEINE FOR MARKET PIGS

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With the possible exception of the week immediately following birth, the period from weaning time until a weight of about 50 pounds is reached is the most critical in the life of a market hog. The change from his mother's milk to the man-made ration offered him is all too often so wide that it really is surprising how quickly the orphaned youngster manages to adjust himself to the new feed combination.

Under most conditions of pig raising in Eastern Canada, the difficulties arising from this change in ration at weaning time appear to be intimately connected with either the protein, mineral, or vitamin nourishment of the pig, if indeed not with all three. An insufficient supply of biologically satisfactory protein, which may be the result of too meagre an allowance of total protein or a combination of proteins of low biological value, or both, is very generally met with wherever dairy by-products are not available and fed in abundance. Even when rations are compounded according to the recognized feeding standards the protein level is far below that which the young pig was receiving while nursing. When we realize that on a 90 per cent dry matter basis, sow's milk carries some 30 per cent of protein while Morrison's standard calls for a ration carrying only 16 per cent of protein for pigs from 30-50 lbs. live weight, it is easy to believe that this sudden cutting in half of the supply of the tissue building material tends toward a slowing-up, for a time at least, in the rate of growth. Couple with this the fact that the nutritive value of the proteins of milk is consderably higher than that of such proteins as are found in the average pig meal and the importance of the protein content of the weanling pig ration is clear. It alone may limit the progress of newly weaning pigs.

Also the satisfactory mineral nutrition of the young pig obviously depends partly on the supply of mineral material available to him. This is relatively easy to provide and at a very low cost.

There is, however, the fact to be considered that only when there is present with the minerals (lime and phosphorous) a supply of vitamin D, can the body properly build these materials into its bone structure. Rickets is the penalty for a shortage of the antirachitic vitamin, which, excepting during the summer months when the animals are exposed to direct sunlight, must be supplied in the feed.

Since without minerals normal growth cannot proceed, a shortage of either the minerals themselves or of the vitamins which enables their utilization in the body may also become limiting factors in the progress of the pig.

"Provendeine" is a product advertised to "Improve the digestibility of all cereal foods, ensure the assimilation of the mineral salts in the food,

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prevent rickets, and to make the growth promoting power of vegetable protein equal to that of animal protein."

These features are claimed in view of the inclusion in this product of cellulose-splitting bacteria and enzymes which they secrete, certain essential animo acids ordinarily lacking in the proteins of cereal feeds, a supply of minerals, and vitamin D as produced by the irradiation of ergosterol.

The Animal Husbandry Department of Macdonald College has for several years been studying the problem of feeding newly weaned pigs and at the request of the Losa Company of Canada, distributors of Provendeine, their product was used in one of our comparative feeding trials for weanling pigs. The procedure to be followed was submitted to and approved by the Losa Company. The results obtained from this trial follow.

Objects of the Trial

Specifically, the object of this trial was to study the effect on rate of gain, incidence of rickets, and general health and vigor of the pigs of substituting Provendeine for a part of the ground limestone in the regular Madonald College Protein-Mineral supplement.

Experimental Periods

The experimental feeding periods consisted of a 30 day period immediately following weaning, during which the Provendeine ration was fed, and two further periods of 60 and 30 days respectively during which the records were kept in order to note any delayed or continued effects of the Provendeine. The first pair of pigs went on feed on May 2nd, 1931. The exact dates of the feeding periods are given in table 1.

Animals Used

Ten pairs of purebred Yorkshire pigs were used in this trial. All were raised at the Macdonald College stock farm. Five different litters were represented, though the sows were all raised in the Macdonald College herd and were of similar breeding. The litters were sired by two different boars.

Previous to weaning, all three litters had been confined to farrowing pens within the piggery and handled as nearly alike as possible. They were not exposed to direct sunlight at any time from birth to market weight. The nursing sows received a ration consisting only of meal and water, hand-fed three times daily as a slop. The meal mixture fed to the sows for the first month after farrowing consisted of:

300 lbs. ground barley	250 lbs. wheat middlings
300 " " corn	300 " Macdonald Protein Supplement.

After the first month of nursing and until weaning the following mixture was used:

200 lbs. ground barley	200 lbs. ground wheat
250 " " corn	200 " Macdonald Protein Supplement[2]

This change was made in order that any food the young pigs might steal from the sow's trough would be the same (excepting for the Provendeine)

[2] See "Rations Fed" for composition of Macdonald Protein Supplement.

that they were to receive following weaning. This plan we have found to be a help in getting pigs through the weaning period without too drastic a change in ration and the attending ill effects on their progress.

Allotment Consideration

Allotment was by pairs. While no attempt was made at uniformity between pairs, the pair mates were selected to be as nearly alike as possible in live weight, age, sex, breeding and thrift. The details of the allotment are given in table 1.

Table 1.—*Identification of pigs and allotment.*

Pair No.	Pig No.	Breeding		Sex	Date Weaned	Age at Weaning	Initial Weight
		Dam	Sire				
1	30	P81	OLP 702	F	May 2	48	22
	40	P81	"	F	"	48	22
2	31	P81	"	F	June 1	48	16
	41	P90	"	F	"	52	17
3	32	Q157	OLF 429	M	"	64	27
	42	Q157	"	M	"	64	26
4	33	Q157	"	M	"	64	28
	43	Q157	"	F	"	64	28
5	34	Q157	"	F	"	64	29
	44	Q157	"	F	"	64	30
6	35	P99	"	F	"	61	25
	45	P99	"	F	"	61	25
7	36	P99	"	F	"	61	28
	46	P99	"	F	"	61	28
8	37	P99	"	F	"	61	28
	47	P99	"	F	"	61	26
9	38	P99	"	F	"	61	27
	48	P99	"	F	"	61	28
10	39	Q157	"	F	"	64	29
	49	P100	"	F	"	62	30

As will be noted from the above table, in four pairs the pair mates were of the same initial weight, five differed by one pound, and one pair by two pounds. In all but two cases pair mates were litter mates and hence of the same age and breeding. With one exception also, pair mates were of the same sex.

Housing and Management During Trial

Throughout the trial, excepting for weighing, all pigs were confined individually to pens about 4 feet by 5 feet in size, pair mates in adjacent pens. These pens were inside the central piggery and did not offer the chance of direct sunlight at any time during the trial. The floors were of plank laid over concrete. Straw bedding was used in sufficient amounts to keep the pens reasonably dry.

Feed containers, which were filled as necessary with weighed quantities of feed, were provided for each pig. Pigs were hand-full-fed, each pig from his own feed bin, feed consumption for the period being checked on each weigh day. Feeding was done three times a day. The dry meal allowance was measured out into the troughs and the water allowance poured over it.

Rations Fed

Pigs Nos. 30 to 39 inclusive were known as Lot 1, and Nos. 40 to 49 at Lot II; Nos. 30 and 40, 31and 41, etc., being pair mates. During the 30-day period immediately following weaning Lot I received the check ration and Lot II the Provendeine combination. Both Lots received the same basal mixture and the same proportion of protein supplement as follows:

Ground corn	250 lbs.
Ground barley	200
Wheat middlings	250
Protein Supplement	300

The protein supplements used were as follows:

	Lot I Macdonald Protein Supplement	Lot II Protein Supplement with Provendeine
Tankage (60%)	120 lbs.	120 lbs.
Oilmeal	60	60
Fish meal	60	60
Bone meal	30	30
Ground limestone	22.8	12.8
Provendeine	—	10
Salt	6	6
Ferric Oxide	1.2	1.2
	300	300

At the conclusion of the 30-day weanling period, the Macdonald College Protein Supplement (as fed Lot I) was used for all pigs of both Lots. The basal feed, however, and the proportions of basal feed to supplement were altered so that for the next 60 days the first five pairs of pigs went onto a ration of 80 per cent ground corn and 20 per cent Macdonald Protein Supplement while the second five pairs received ground barley instead of corn as the basal feed. For the 30 days following this 60-day growing period, the proportion of protein supplement was reduced to 10 per cent of the ration, and the basal feeds increased accordingly.

This division of the lots was done to see whether or not the feeding of Provendeine to the weanling pigs would affect differently their later gains on a corn ration as compared to a barley ration.

Observations During Trial

Shortly after they went on feed pigs Nos. 34, 42, and 44 showed signs of a skin rash and on June 16th these pigs were treated with sulphur, each pig receiving mixed in his feed, 1⅓ tablespoonful per day of sulphur

Details of the rations fed.

Feeding Periods	Feeds	Lot I. Pigs 30-34	Lot I. Pigs 35-39	Lot II. Pigs 40-44	Lot II. Pigs 45-49
Period I.	Barley	200	200	200	200
	Wheat Middlings	250	250	250	250
30 days	Corn	250	250	250	250
following	Mac. Prot. Supl.	300	300	...	...
weaning.	Prot. Supt. with 3% Provendeine.	...	...	300	300
Period II.	Barley	...	800	...	800
60 days	Corn	800	...	800	...
following	Mac. Prot. Suppl.	200	200	200	200
Period I.					
Period III.	Barley	...	900	...	900
30 days	Corn	900	...	900	...
following	Mac. Prot. Suppl.	100	100	100	100
Period II.					

for three days. The rash disappeared in about two or three days following the treatment.

On June 22nd pig No. 43 showed an umbilical rupture. This continued throughout the trial and when shipped to market it was fully six inches in diameter. On August 19th this pig also went lame in her fore legs. This condition got worse until when her feeding periods were completed on September 29th she was unable to stand on her fore feet but for a few minutes at a time. During the last week she did not feed as well as she had previously, which may or may not have been the result of her legs and rupture.

On July 22nd pig No. 42 showed an umbilical rupture. This, however, did not appear to affect the progress of this pig. It never got much larger than about two inches in diameter.

Since pigs Nos. 42 and 43 were littermates it was considered that the ruptures were the result of an hereditary weakness rather than in any way connected with the management of the pigs, though their appearance was delayed beyond the time when they ordinarily occur.

The lameness in the case of pig No. 43 is not easily explained. At the time that the condition was first noticeable this pig was 143 days old and weighed 180 lbs. If the condition was a form of rickets its appearance not only followed the feeding of Provendeine but was delayed much beyond the time when rickets is usually looked for. In any case, there was no evidence of any lack of thrift nor any interruption in growth evident with this pig up to this time, though as noted above she was, about a month later, somewhat off feed for the last few days of the trial.

The Data

In table 2 is given the record of weights, gains, feed consumption, gain per 100 lbs. feed eaten and feed required to produce 100 lbs. gain.

A summary of the data in table 2 is found in table 3.

TABLE 2.—*Weights, Gains and Feed Eaten by Periods.*

	LOT 1. MACDONALD COLLEGE PROTEIN-MINERAL SUPPLEMENT. Pigs Nos. 30 to 39 inclusive.											LOT 2. PROVENDEINE MIXTURE. Pigs Nos. 40 to 49 inclusive.									
	Pair No.	Initial Wt.	Final Wt.	Gain	Corn	Barley	Wheat Middlings	Protein Mineral Supplement	Total Air Dry Feed Eaten	Air Dry feed per 100 lbs. Gain	Gain per 100 lbs. Air Dry Feed	Initial Wt.	Final Wt.	Gain	Corn	Barley	Wheat Middlings	Protein Mineral Supplement	Total Air Dry Feed Eaten	Air Dry feed per 100 lbs. Gain	Gain per 100 lbs. Air Dry Feed
Period I 30 days following weaning.	1	22	52	30	18.5	14.8	18.5	22.2	74	246.7	41	22	51	29	20.3	16.1	20.3	24.3	81	279.3	36
	2	16	43	27	17.0	13.6	17.0	20.4	68	251.8	39	17	46	29	17.8	14.1	17.8	21.3	71	244.8	41
	3	27	65	38	23.8	19.0	23.8	28.4	95	250.0	40	26	69	43	31.0	24.8	31.0	37.2	124	288.3	35
	4	28	75	47	29.3	23.4	29.3	35.0	117	248.9	40	28	75	47	29.3	23.4	29.3	35.0	117	248.9	40
	5	29	75	46	30.0	24.0	30.0	36.0	120	260.1	38	30	73	43	31.3	25.0	31.3	37.4	125	290.6	34
	6	25	63	38	28.8	23.0	28.8	34.4	115	302.6	33	25	61	36	25.0	20.0	25.0	30.0	100	277.7	36
	7	28	74	46	28.0	22.4	28.0	33.6	112	243.4	41	28	77	49	33.0	26.0	33.0	38.0	130	265.3	38
	8	28	72	44	30.5	24.4	30.5	36.6	122	277.2	36	26	64	38	29.3	23.4	29.3	35.0	117	307.8	32
	9	27	66	39	28.0	22.4	28.0	33.6	112	287.1	35	28	69	41	27.8	22.2	27.8	33.2	111	270.7	37
	10	29	60	31	25.0	20.0	25.0	30.0	100	322.5	31	30	67	37	28.3	22.6	28.3	33.8	113	305.4	33
Period II 60 days following Period I.	1	52	136	84	284.8			71.2	356	423.8	24	51	151	100	300.8			75.2	376	376.0	27
	2	43	107	64	230.4			57.6	288	450.0	22	46	140	94	288.0			72.0	360	382.9	26
	3	65	162	97	320.8			80.2	401	413.4	24	69	183	114	371.2			92.8	464	407.0	25
	4	75	182	107	376.8			94.2	471	440.1	23	75	188	113	381.6			95.4	477	422.1	24
	5	75	183	108	378.4			94.6	473	437.9	23	73	168	95	376.0			94.0	470	494.7	20
	6	63	144	81		320.0		80.0	400	493.8	20	61	141	80		314.4		78.6	393	491.2	20
	7	74	161	87		331.2		82.8	414	475.8	21	77	171	93		331.2		82.8	414	445.1	22
	8	72	151	79		337.6		84.4	422	534.1	19	64	151	87		332.8		83.2	416	478.1	21
	9	66	163	97		348.0		87.0	435	448.4	23	69	154	85		334.4		83.6	418	491.7	20
	10	60	133	73		292.0		73.0	365	636.9	20	67	158	91		320.0		80.0	400	439.5	23
Period III 30 days following Period II.	1	136	187	51	216.9			24.1	241	472.5	21	151	204	53	213.3			23.7	237	447.1	22
	2	107	146	39	154.8			17.2	172	441.0	23	140	197	57	221.4			24.6	246	431.5	23
	3	162	227	63	213.3			23.7	237	376.1	27	183	254	71	225.9			25.1	251	353.5	28
	4	182	249	65	224.1			24.9	249	383.0	26	188	233	45	215.1			23.9	239	531.1	19
	5	183	257	72	230.4			25.6	256	355.5	28	168	232	64	230.4			25.6	256	400.0	25
	6	144	201	56		196.2		21.8	218	389.2	26	141	199	58		194.4		21.6	216	372.4	27
	7	161	223	61		199.8		22.2	222	363.9	27	171	231	60		199.8		22.2	222	370.0	27
	8	151	207	55		199.8		22.2	222	403.6	25	151	214	63		199.8		22.2	222	352.3	28
	9	163	213	48		180.0		20.0	200	416.6	24	154	210	56		199.8		22.2	222	396.4	25
	10	133	167	33		144.0		16.0	160	484.8	21	158	217	59		197.1		21.9	219	371.1	27

TABLE 3.—*Period I.* (*30 days following weaning*).

	Lot I. Macdonald Protein Supplement	Lot II. Provendeine
No. Pigs	10 (Nos. 30-39 incl.)	10 (Nos. 40-49 incl.)
Initial Weight	25.9 lbs.	26.0 lbs.
Gain	38.6	39.2
Average Daily Gain	1.29	1.31
Feed Eaten 30 days:		
Gr. Corn	25.9	27.3
Gr. Barley	20.7	21.7
Wheat Middlings	25.9	27.3
Macdonald Protein Supp.	31.0	....
Provendeine Mixture	....	32.5
Total	103.5	108.8
Total Feed per 100 lbs. gain	267.4	275.5
Gain per 100 lbs. feed eaten	37.4	36.2

TABLE 3.—*Period II.* (*60 days following period I.*)

	Lot I		Lot II	
	Ia Corn	Ib Barley	IIa Corn	IIb Barley
No. Pigs	5 (Nos. 30-34)	5 (Nos. 35-39)	5 (Nos. 40-44)	5 (Nos. 45-49)
Initial Weight	62.0	67.0	62.8	67.6
Gain	92.0	83.4	103.2	87.2
Av. Daily Gain	1.53	1.39	1.72	1.45
Feed eaten 60 days:				
Gr. Corn	318.2	....	343.5	....
Gr. Barley	....	325.8	....	326.5
Mac. Protein Supplement	79.6	81.4	85.9	81.7
Total	397.8	407.2	429.4	408.2
Total feed per 100 lbs. gain	431.0	485.4	409.8	471.7
Gain per 100 lbs. feed eaten	23.2	20.6	24.4	21.2

TABLE 3.—*Period III.* (*30 days following period II*).

	Lot I		Lot II	
	Ia Corn	Ib Barley	IIa Corn	IIb Barley
No. Pigs	5 (Nos. 30-34)	5 (Nos. 35-39)	5 (Nos. 40-44)	5 (Nos. 45-49)
Initial Weight	154.0	150.4	166.0	155.0
Gain	59.2	51.8	58.0	59.2
Av. Daily Gain	1.97	1.73	1.93	1.97
Feed eaten 30 days:				
Gr. Corn	207.9	....	221.2	....
Gr. Barley	....	183.9	....	198.2
Mac. Protein Supplement	23.1	20.5	25.0	22.0
Total	231.0	204.4	246.2	220.2
Feed per 100 lbs. gain	393.7	400.0	427.4	373.1
Gain per 100 lbs. feed eaten	25.4	25.0	23.4	26.8

TABLE 3.—*Summary of all three periods.*

	Lot I			Lot II		
	Ia Corn	Ib Barley	Ia + Ib	IIa Corn	IIb Barley	IIa + IIb
No. Pigs	5 (Nos. 30-34)	5 (Nos. 35-39)	10 (Nos. 30-39)	5 (Nos. 40-44)	5 (Nos. 45-49)	10 (Nos. 40-49)
Gain	188.8	174.8	181.6	194.4	186.6	193.1
Daily Gain	1.57	1.45	1.51	1.66	1.55	1.61
Feed eaten 120 days						
Gr. Corn	549.8	28.0	Corn or Barley	590.6	28.6	Corn or Barley
Gr. Barley	18.9	532.2	564.5	20.6	547.5	593.6
Wheat Middlings	23.7	28.0	25.9	25.9	28.6	27.3
Protein Supplement	131.1	135.5	133.3	141.9	137.7	139.8
Total	723.5	723.8	723.7	779.0	742.4	760.7
Total feed per 100 lbs. gain	383.2	414.1	398.5	390.7	397.8	393.9
Gain per 100 lbs. feed eaten	26.1	24.1	25.1	25.6	25.1	25.4

It must be remembered in studying table 3 that following the weanling period, during which Lot I received the Macdonald College Protein Supplement and Lot II the combination containing Provendeine, each lot was divided; the first five pigs of each lot (30-34 of Lot I and their pair mates 40-44 of Lot II) going onto a basal feed of corn (Lots Ia and IIa respectively) while the last five pairs received barley (Lots Ib and IIb respectively) as the basal feed.

Thus a comparison of Lots Ia and IIb is one between pigs which were on the check ration vs. those on Provendeine, while Lot Ia vs. Ib involves pigs having had the same previous treatment but following their weanling period were on different basal feeds. Comparisons of Lots Ia vs. Ib and IIa vs. IIb (i.e. corn vs. barley) must be made with caution since pigs 30-34 were not paired with Nos. 35-39, nor Nos. 40-44 with Nos. 45-49. However, the average performance of these sub-groups may not only indicate a possible difference in subsequent gains following Provendeine feeding between basal rations of corn as compared to barley (Ia vs. IIa and Ib vs. IIb) but may also be suggestive of differences between corn and barley for pigs having had similar previous rations (Ia vs. Ib and IIa vs. IIb).

ANALYSIS OF DATA

Weanling Period

From table III it is seen that the Provendeine fed pigs made on the average 1.5 per cent faster gains during this period. The feed consumption of this Lot, however, was 5.2 per cent greater than the check Lot so that in feed required for a unit of gain or gain made per unit of feed eaten, there was a difference of 3 per cent in favor of the check Lot (Lot I).

Statistical analysis shows that we would expect from chance alone a difference as great as the 1.2 lbs. observed in gain per 100 lbs. feed eaten in about one case out of three. Thus under the demand that the probability of a difference as great as the one observed shall not occur from chance alone oftener than once in 20 cases, means that we are unable to consider this difference of significance in so far as its being due to the experimental difference in ration is concerned.

TABLE 4.—*Statistical analysis* of weaning periods.*

Mean difference in gains per 100 lbs. feed eaten between pairs in favor of Lot II	1.2 lbs.
Standard deviation of differences	3.28 "
Value of t	1.156
P for above value of t	approx. .25
Minimum difference necessary to cover uncontrolled variability for P = .05	2.33 lbs.

* See appendix for formulae used in analysis.

It appears from the above that for the weanling period the Provendeine affected no significant difference in gains measurable in this trial. Nor was there evidence of any other effect of this product during this feeding period, both lots appearing thrifty and vigorous throughout the period.

Periods II and III.

During periods II and III there was a perceptible tendency for the pigs which had previously been on the Provendeine mixture (Lot II) to show larger gains, eat more feed, and to make slightly more efficient use of their feed eaten as measured by the gains per 100 lbs. of feed eaten, although during Period III Lot IIa made a relatively poor showing, due almost entirely to the performance of pig No. 43 as will be seen from inspection of Table II, and whose case has already been discussed earlier in this report.

The differences in per cent are shown in table 5.

TABLE 5.—*Differences—periods II and III.*

	Lot Numbers	Period II 60 days	Per od III 30 days
% Difference in Gains	Lot IIa vs. Lot Ia (corn)	+12.4%	— 2. %
	Lot IIb vs. Lot Ib (barley)	+ 4.3	+13.8
	Av. Lot II vs. Lot I	+ 8.3	+ 5.9
% Difference in Feed	Lot IIa vs. Lot Ia (corn)	+ 8.	+ 6.5
	Lot IIb vs. Lot Ib (barley)	+ .25	+ 7.7
	Av. Lot II vs. Lot I	+ 4.1	+ 7.1
% Difference in Gains per 100 lbs. Feed	Lot IIa vs. Lot Ia (corn)	+ 5.2	— 7.9
	Lot IIb vs. Lot Ib (barley)	+ 2.9	+ 7.2
	Av. Lot II vs. Lot I	+ 4.1	— .3

(+ indicates a difference in favor of Lot II).

None of the differences, however, are sufficiently large to cover odds of 20 to 1 against their being due to chance rather than to the previous feeding of Provendeine, as is indicated in table 6.

TABLE 6.—*Statistical analysis for periods II and III.*

	Period II	Period III
Mean difference in gain per 100 lbs. feed eaten	.9 lbs.	—.1 lbs.
Standard deviations of differences	2.38 "	3.78 "
Value of t	1.195	.084
P for above value of t (approx.)	.25	1.0
Minimum difference necessary to cover uncontrolled variability for P = .05	1.70 "	2.70 "

Combined Periods:

Considering the trial on the basis of the effect on the market hog of feeding Provendeine for a month following weaning, we find an average difference of 3.6 per cent in favor of Lot II (Provendeine). Between pair mates six cases showed favorable, and three cases against the Provendeine group. In one pair results were equal. Differences ranged from 0 to 4 lbs. gain per 100 lbs. feed eaten.

A statistical study for the combined periods gave the following results:

TABLE 7.—*Statistical analysis for periods I, II, and III, combined.*

Mean differences in gain per 100 lbs. feed eaten	.5 lbs.
Standard deviation of differences	1.95 "
Value of t	.81
P for above value of t (approx.)	1.
Minimum difference necessary to cover uncontrolled variability for P = .05	1.39 lbs.

From the above table it is found that differences as great as obtained in this trial may be expected to occur from chance alone as often as not, or on the basis of odds of 20 to 1, any differences less than 1.39 lbs. must be regarded as possibly being due to chance rather than to the imposed experimental conditions.

Barley vs. Corn

In so far as this trial was concerned with respect to barley vs. corn for growing and finishing hogs, the results were in accord with previous findings of this Department (see Macdonald College Technical Bulletin No. 9) viz. that, "As measured by total feed consumption, barley is somewhat less palatable than corn . . ."

Less feed was consumed and less rapid gains made by the barley fed pigs, and the gain per unit of feed eaten was slightly in the favor of corn.

As previously noted the barley-corn comparison in this trial was a secondary feature and should be regarded as suggestive only. The data for this comparison are presented as of interest rather than as being conclusive.

The difference of 4.8 per cent in favor of the barley fed hogs in the matter of economy of feed utilization is probably not outside that required for significance, but the difference in rate of gain might often be of importance to the feeder in the matter of time necessary to reach market weight.

TABLE 8.—*Corn vs. Barley.*

	Corn	Barley
No. of pigs	10	10
Av. initial weight	62.4 lbs.	67.3 lbs.
Gain 90 days	156.2	140.9
Daily gain	1.73	1.56
Feed eaten:		
Corn	545.5	....
Barley	....	517.3
Protein Supplement	106.5	102.7
Total feed	652.0	620.0
Feed per 100 lbs. gain	418.0	440.0
Gain per 100 lbs. feed eaten	23.9	22.7

SUMMARY AND CONCLUSIONS

1. Provendeine, fed to Yorkshire pigs during a period of 30 days following weaning at the rate of 1 per cent of their ration effected no significant difference from the check Lot during this period measurable by this test, either in gains in weight or in thrift of the pigs.
2. During the 90 days following this 30 day period, the pigs previously fed Provendeine showed a tendency to slightly larger gains per 100 lbs. of feed than did the check Lot. Statistical analysis indicated that differences as great as those observed might be expected from chance alone in about one case out of three. With odds of 20 to 1, however, the difference could not safely be considered as due to the experimental difference.
3. It would seem questionable, therefore, whether the Provendeine effected any significant difference on the subsequent gains of the pigs.
4. It would seem logical, therefore, to conclude that with thrifty pigs and a properly balanced feed, Provendeine is an unnecessary addition to the ration.
5. Barley appeared to be less palatable than corn for market hogs.

FORMULAE USED IN STATISTICAL ANALYSIS

Standard deviation of differences between pair mates in gains per 100 lbs. air dry feed $= \frac{\sqrt{\Sigma\ d^2}}{n}$

Value of t (see Fisher, "Statistical Methods for Research Workers, "3rd Ed. p 105) $= \frac{Md\ \sqrt{n^1}}{\sigma}$

Probability for value of t (above) (See Fisher's table of t values p. 139)

Minimum difference necessary for P of .05 (odds of 20-1) $= \frac{t \text{ (for P=.05)} \times \sigma \text{ of differences}}{\sqrt{n^1}}$

(In above formulae $n = n^1 - 1$, where n^1 = number of variates.)

In making statistical studies the mean gains per 100 lbs. feed eaten of individual animals *calculated to the nearest whole pound* have been used, which accounts for the slight discrepancy sometimes noted in the differences between the average gain per 100 lbs. feed eaten shown in table 2 and the mean differences shown in the statistical summary.

CHEMICAL COMPOUNDS LETHAL TO YEASTS AND BACTERIA

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The destruction of yeast cultures by solutions of various compounds was studied partly to assist the British Columbia fermentation industries in evaluating miscellaneous disinfectant washes and preservatives; and to obtain information upon the relative toxicity of specific chemicals to fungi in general. Phenol and several other compounds were lethal to cultures of a yeast species and *Bacterium juglandis*, at approximately the same concentrations, therefore, it may be assumed that the data obtained with respect to the yeast culture only, is applicable to *B. juglandis*, an important plant pathogen, and possibly to many other fungi.

A review of the literature has yielded comparatively little information upon the lethal concentrations of chemicals toward yeasts. Marboe (*1*) has observed that for equal concentrations of the metallic ion, those most toxic are silver, mercury, copper, cadmium and chromium, while magnesium, bismuth, iron and manganese have no effect. Stockhausen (*2*) has found that yeasts are killed in a short time when treated with a .85 per cent solution of sodium chloride in the presence of N/10 acid or alkali. Myers (*3*) notes that a yeast pathogenic to man is killed by a saturated aqueous solution of thymol in one minute, while sixty minutes exposure to 1 per cent phenol is required to kill the same organism.

EXPERIMENTAL

The technique employed in these determinations of lethal concentrations of chemicals was a modification of the U. S. Hygienic Laboratory Method (*4*), and very similar to the method outlined by Reddish (*5, 6*). Yeast No. 121, a rapid growing film former, was used as the test organism. C.P. chemicals were used and the dilutions were made with distilled water. The nutrient medium of both stock and transfer cultures was approximately pH 5. and of the following composition:

NaCl	.2 gm.
$MgSO_4$.$7H_2O$	.2 gm.
$Ca(NO_3)_2$	.2 gm.
KH_2PO_4	.5 gm.
$(NH_4)_2SO_4$	2.0 gms.
Peptone	1.0 gm.
Dextrose	20.0 gms.
Distilled water	1000. ccs.

Comparable experimental conditions were created (1) by employing stock cultures of yeast No. 121 and *B. juglandis* of the same age, 96 hours at 25°C.; (2) by maintaining the tubes of culture plus disinfectant at a constant temperature, 20°C.; (3) by recording the lethal concentrations after incubation of the transfer tubes for a uniform period, 4 days at 25°C.; (4) by adopting a standard platinum 24 gauge wire, 4 mm.

loop, for transfer purposes; and (5) by using a 5.5 per cent stock solution of C.P. phenol having a congealing point of 40°C as the reference disinfectant.

The procedure in brief, was as follows: 10 dilutions of each disinfectant were usually employed. At intervals of 30 seconds, .5 cc. of liquid culture of the test organism was run into 5 ccs. of each dilution from a small burette. At intervals of 5, 10 and 15 minutes, transfers of each mix were made back to a tube of sterile media with the platinum loop. This allowed 30 seconds between each transfer when 10 dilutions were employed. The inoculated transfer tubes were then incubated at 25°C, and after 4 days, the lethal concentrations were noted.

The lethal concentration is defined as the greatest dilution of the disinfectant which will kill the organism in 10 and 15 minutes but not in 5. The phenol coefficient was then obtained by dividing the lethal concentration of the toxic agent by the corresponding concentration of phenol required to kill the organism in the same interval of time.

The data in table 1 consist of the lethal concentrations and phenol coefficients of the chemicals that killed the yeast at some point within the range of concentrations investigated.

TABLE 1.—*Concentrations and phenol coefficients of chemical compounds lethal to yeast No. 121.*

Compound	Lethal Concentration	Phenol Coefficient
Phenol	1 – 110	1.0
Chinosol	1 – 120	1.1
Creosote (Beechwood)	1 – 230	2.1
Cupric acetate	1 – 75	.7
Ethyl alcohol	1 – 3	.03
Formaldehyde	1 – 250	2.3
Guaiacol	1 – 130	1.2
Hexyl resorcinol	1 – 15000	135.0
Malachite Green Y.S.	1 – 900	8.2
Mercuric chloride	1 – 9000	81.4
Methyl Violet 10 B.S.	1 – 900	8.2
Picric acid	1 – 250	2.3
Potassium bisulphite	1 – 225	2.0
" " and 5% alcohol by vol.	1 – 300	2.7
" " and 10% " "	1 – 450	4.1
" " and 15% " "	1 – 750	6.8
" " and 20% " "	1 – 1700	15.5
Potassium permanganate	1 – 12000	109.0
Potassium polysulphide resinate	1 – 50	.45
Potassium polysulphide resinate & .1% creosote	1 – 50	.45
Silver nitrate	1 – 9000	81.4
Sodium salicylate	1 – 5	.04
" " and 5% alcohol by vol.	1 – 75	.68
" " and 10% " "	1 – 225	2.0
" " and 15% " "	1 – 650	5.9
" " and 20% " "	1 – 1500	13.6
Sodium sulphide	1 – 75	.7
Sulphite waste liquor (from pulp plant)	1 – 10	.09

In table 2 are listed the chemicals which did not kill the yeast at the concentrations recorded—the maximum concentrations investigated. In many cases the preparation of higher concentrations was limited by the solubility of the compound.

TABLE 2.—*Chemical compounds not lethal to yeast No. 121, up to the concentrations recorded.*

Compound	Concentration
Auramine O.S.	1 – 100
Cadmium sulphate	1 – 10
Cheshunt compound	1 – 10
Cupric sulphate	1 – 20
Dip Dust	1 – 100
Ferric chloride	1 – 10
Ferric sulphate	1 – 10
Fluorescein LTS	1 – 100
Indine Blue 2 RS	1 – 100
Magenta P S	1 – 100
Potassium acetate	1 – 10
Potassium chloride	1 – 10
Potassium cyanide	1 – 20
Potassium dichromate	1 – 20
Potassium ferrocyanide	1 – 10
Potassium iodate	1 – 20
Potassium iodide	1 – 10
Potassium nitrate	1 – 10
Rhodamine B S	1 – 100
Saponin	1 – 10
Sodium benzoate	1 – 10
Sodium fluoride	1 – 20
Sodium nitroprusside	1 – 20
Urea	1 – 10
Uspulun	1 – 100
Waste sulphite liquor (neutralized)	1 – 1.1

The data in table 3 consist of the lethal concentrations and phenol coefficients of chemicals that killed *Bacterium juglandis* when used in place of yeast No. 121, as the test organism. All other conditions were identical except that the nutrient medium was adjusted to pH 7., instead of pH 5. A comparison of the phenol coefficients with those of the same chemicals in table 1, will show a similarity.

TABLE 3.—*Concentrations and phenol coefficients of chemical compounds lethal to Bacterium juglandis.*

Compound	Lethal concentration	Phenol coefficient
Phenol	1 – 110	1.0
Hexyl resorcinol	1 – 15000	136.0
Mercuric chloride	1 – 9000	81.4
Potassium permanganate	1 – 12000	109.0
Potassium polysulphide Resinate	1 – 100	.9
Potassium polysulphide Resinate and .1% creosote	1 – 100	.9
Silver nitrate	1 – 12000	109.0

DISCUSSION

Strong oxidizing agents usually possess pronounced disinfectant properties. This generalization is supported in the case of potassium permanganate. This substance affected the destruction of the test yeast at a concentration of 1 part by weight in 12,000 parts distilled water. However, the generalization did not apply in the case of potassium

dichromate. One part in 20 of water was not lethal under the same conditions. The exceptionally large phenol coefficient of potassium permanganate, 109.0, is the probable reason for the greatly increased fungicidal efficiency of flowers of sulphur by the inclusion of 1 or 2 parts permanganate dust per 100 of sulphur.

Summary

1. Using a yeast as the test organism, the lethal concentrations of a number of chemicals were determined. These values are recorded together with a list of compounds that are not lethal at relatively high concentrations. Similar values were obtained when *Bacterium juglandis*, an important plant pathogen, was used in place of the yeast as the test organism.

2. The exceptionally high phenol coefficient of potassium permanganate has been suggested as the probable reason why the fungicidal efficiency of sulphur dust can be greatly increased by the inclusion of a small proportion of permanganate dust.

LITERATURE CITED

1. Marboe, F. Abs. J. Inst. Brewing *36*, 563. 1930.
2. Stockhausen, Abs. J. Inst. Brewing *35*, 583. 1929.
3. Myers, H. B. Jour. Pharmacol. Proc. xxvii, 248, 1926.
4. Reprint 675, U.S. Public Health Rep. *36*, 1559. 1921
5. Reddish, G. F. Am. J. Pub. Health, *17*, 320, 1927.
6. Reddish, G. F. "The Standardization of Disinfectants and Antiseptics", The Newer Knowledge of Bacteriology and Immunology, Univ. of Chicago Press, 301-9. 1928.

LE PROBLEME DE LA MAMMITE AUX ETATS-UNIS

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Le problème de la mammite aux Etats-Unis acquiert une importance de plus en plus grande. Après avoir travaillé deux ans sous les ordres du Dr. Rosell sur cette question, au mois de juin 1931, le Dr. Breedet et le Dr. Hucker de la Ferme Expérimentale de l'Etat de New-York me demandèrent pour entreprendre de nouveaux travaux sur la mammite. Depuis ce temps, je n'ai cessé de m'occuper de ce problème, travaillant aussi avec le Dr. Udall, de l'Ecole de Médécine Vétérinaire de l'Université de Cornell. Qu'il me soit permis de rendre hommage au Dr. Rosell, considéré dans les milieux scientifiques des Etats-Unis et du Canada comme l'initiateur du grand mouvement entrepris. Le Dr. Rosell disait dans un de ses articles: "La mammite sera le grand problème du jour comme la tuberculose l'a été pour les années passées." La prédiction se réalise pleinement aux Etats-Unis. L'éradication de la tuberculose dans les troupeaux laitiers est pratiquement complète, l'avortement épizootique sous bon contrôle. La mammite suscite un grand nombre de travaux, des réunions de vétérinaires un peu partout pour aviser aux moyens à prendre. Les résultats de nos expériences suffisent seuls à démontrer le bien fondé de cette alarme.

L'été dernier, de juin à octobre 1931, nous avons examiné environ 200 vaches disséminées un peut partout dans l'Etat de New-York. Des échantillons de lait de chaque quartier furent obtenus et soumis à une série d'épreuves chimiques et bactériologiques, selon les méthodes que j'avais apprises et pratiquées sous la direction du Dr. Rosell. Nous avons opéré parallèlement avec le chlore, la catalase, la lactose, le brom-thymol bleu, le brom-crésol pourpre, le comptage des leucocytes. De plus un examen physique fut opéré sur chaque quartier individuel par le Dr. Jeunings sous la direction du Dr. Udall. Enfin nous fîmes le "post-mortem" de toutes les mamelles de ces vaches à l'étude qui devaient être destinées à l'abattoir.

Méthode par plaques.

A) Les résultats de 439 quartiers ont été obtenus et rassemblés. Environ 52% n'ont pas montré de colonies de streptocoques sur "veal infusion agar" avec sang ou sur milieu de caséine digérée. Sur 52%, moins de 2% ont montré du pus au "post mortem".

48% de tous les quartiers étudiés indiquaient la présence de streptocoques, presque 18% manifestaient du pus au "post-mortem". Enfin au-dessus de 9% de tous les quartiers examinés contenaient du pus après le post-mortem.

B) Nombre de vaches portant des streptocoques dans un ou plusieurs quartiers.—78% de toutes les vaches indiquaient la présence de streptocoques dans un ou plusieurs quartiers et 21%, du pus après le "post-mortem".

C) Nombre de quartiers affectés de tissus fibreux.

La présence de tissu fibreux dans la mamelle est considérée par les vétérinaires comme suspecte. L'examen physique, opéré par le Dr. Udall,

en a déterminé la présence confirmée par le "post-mortem". Seulement 24% de tous les quartiers examinés ne montraient aucun tissu fibreux. 76% indiquaient une "fibrosis" légère ou marquée. Environ 66% de tous les quartiers accusèrent ce changement à un degré marqué. De plus, 14% de ces cas "marqués" montraient du pus après le "post-mortem" et les streptocoques apparaissaient dans le lait pour une moyenne de 37%.

Confirmant les résultats que nous avions obtenus avec le Dr. Rosell, nous avons constaté que le chlore est peut être la plus délicate et la plus effective des épreuves. Chose curieuse, tous les quartiers qui montraient une induration à l'examen physique accusaient une augmentation en chlore. La catalase et le brom-thymol suivent de près, la sensibilité de cette épreuve étant diminuée par le manque de tubes appropriés. Le "strip cup" et le lactose viennent en dernier lieu. Le "strip cup" est une épreuve que tous les fermiers connaissent bien et qu'ils peuvent exécuter eux-mêmes avec un peu de pratique, surtout en forme de filtre noir.

C'est devant ces résultats que l'intérêt de la question grandit en importance. Une campagne fut entreprise. Le mois dernier, tous les vétérinaires se réunissaient à l'Université de Cornell. Le ministre de l'Agréculture était présent et adressa la parole. Après une revue des travaux opérés dans l'Etat de New-York pour l'éradication de la tuberculose et le contrôle de l'avortement, il engagea les vétérinaires à s'occuper de la mammite. Le Dr. Hucker et le Dr. Udall citèrent les résultats que nous avions obtenus. Une vive discussion s'ensuivit. On en conclut deux choses:

1.—Aucune guérison ne pouvait être obtenue et aucun remède effectif, (à ce moment on n'était pas encore au courant des bons résultats obtenus pas la vaccination entreprise par le Dr. Rosell). Beaucoup d'essais avaient été faits par différents vétérinaires sans aucun effet pratique.

2.—Puisque aucune guérison n'était possible pour le présent, il fallait des moyens pour prévenir et controler l'infection.

On s'appliqua donc à chercher lequel de tous les moyens de diagnostic est le plus approprié. Le Dr. Udall, ayant fait de nombreux travaux sur le côté clinique de la question, suggéra aux vétérinaires l'emploi de l'examen physique tel qu'il le décrit dans un article de la "Renue Vétérinaire de l'Université de Cornell, Vol. XXI, No. 2, Avril 1931." Le brom-thymol bleu fut aussi accepté à cause de la facilité de l'opération dans l'étable même. Enfin l'épreuve du chlore fut adoptée. Tous les vétérinaires ne peuvent utiliser cette épreuve à cause de la quantité de matériel exigé, mais il leur est facile d'envoyer les échantillons de lait à un laboratoire voisin où cette épreuve peut être conduite, même plusieurs heures après le prélèvement de l'échantillon, puisque ce n'est pas une question d'acidité.

Depuis ce temps, je dois dire que je n'ai cessé de renseigner les vétérinaires sur le chlore et le brom-thymol.

2.—Pour ce qui est des moyens préventifs, ils ont adopté le système de division de l'étable en 3 parties: vaches infectées, vaches suspectes et vachesn ormales. Je renvoie ici aux nombreux articles écrits par le Dr. Rosell à ce sujet ainsi qu'à l'article du Dr. Udall ce-dessus mentionné et à une autre Revue Vétérinaire de l'Université de Cornell, Vol. XX, No. 2, avril 1930.

Depuis ce temps, les résultats encourageants que le Dr. Rosell a obtenus avec la vaccination ont de nouveau stimulé l'intérêt. Le Dr. Udall m'a proposé d'en renouveler l'essai selon les méthodes employées par le Dr. Rosell.

Le problème de la mammite demeure donc aux Etats-Unis un grand problème économique qui suscitera de plus en plus l'effort de tous les hommes de science.

RESUME DES ARTICLES PUBLIES EN ANGLAIS DANS CE NUMERO

L'APPROVISIONNEMENT EN GRAINS PENDANT LES DEUX GUERRES NAPOLEONIENNE ET EUROPE-G. E. Fussell, London, England.

L'auteur, s'occupant de recherches historiques sur l'agriculture en Angleterre donne un très intéressant exposé des efforts de l'Angleterre, Ecosse et Galles pour se subvenir avec leur propre grain durant les périodes de guerre. Les statisticiens des guerres Napoléoniennes estimaient que la production de grain domestique en Grande Bretagne équivalait à un approvisionnement en nourriture pour au moins quarante-deux semaines. Durant la Grande Guerre il fut possible par des méthodes de surproduction de produire seulement un approvisionnement pour environ vingt-deux semaines. Il semblerait donc que la Grande-Bretagne dépend principalement sur les importations de grains et que malgré l'application de méthodes extraordinaires, la quantité de produits alimentaires dérivant des céréales cultivées au pays ne peut être augmentée que dans une faible mesure.

LA NEMATODE DE LA BETTERAVE A SUCRE, *Heterodera Schachtii*.—UN NOUVEAU PARASITE AU CANADA. Harold D. Brown, Dominion Sugar Company, Chatham, Ont.

Cet insecte, nouveau au Canada fut découvert en Août, 1931, dans un champ de betteraves à sucre à Glencoe, Ont. Les officers du Service de l'Entomologie Fédèral furent immediatement informés et le champ attaqué fut isolé et des mesures prises afin de prévenir toute propagation.

Ces insectes, appelés aussi anguillules de la racine appartiennent à la famille des vers ronds. L'on peut difficilement les voir à l'oeil nu. Ils se reproduisent très rapidement, s'attachent aux racines de la betterave et en suçent le suc. Ceci retarde la croissance et entraine la production d'un nombre excessif de radicelles ainsi que la flétrissure des feuilles, ce qui a donné naissance à l'expression française: "Fatigue des terres cultivées en betteraves." L'on pense que ces nématodes sont entrées au Canada, avec la poussière adhérant généralement à la graine de betteraves à sucre importées d'Allemagne, Danemark ou de Tchécoslovaquie. La rotation des récoltes est le principal moyen de contrôle. Une rotation de quatre ou cinq ans comprenant au moins une récolte de foin de légumineuse est recommandée

PROVENDEINE POUR LES PORCS A L'ENGRAIS. E. W. Crampton, Collège Macdonald, P.Q.

Un aliment commercial connu sous le nom de "Provendeine" a été essayé avec des groupes de porcs soumis à des expériences sur l'alimentation, au Collège Macdonald. Le produit est annoncé pour "augmenter la digestibilité de tous les aliments à base de céréales, assurer l'assimilation des sels minéraux des aliments, prévenir le rachitisme et rendre la proteine végètable égale à la proteine animale surtout en ce que concerne son pouvoir de favoriser la croissance". Dix groupes de porcs purs Yorkshires furent employés et l'on a constaté qu'aucun résultats appreciables furent obtenus. Au cours de la même experience l'on à trouvé que l'orge apparaît être moins appétissante que le blé d'inde pour les porcs à l'engrais.

COMPOSES CHIMIQUES DESTRUCTIFS DE LA LEVURE ET DES BACTERIES. William Newton et Howard I. Edwards, Laboratoire Fédèral de Pathologie, Saanichton, B.C.

Expériment sur la levure, l'action meurtrière d'un certain nombre de composés chimiques fut déterminée. Les composés chimiques qui furent "mortels" sont classés au tableau I et ceux dont l'action n'est "pas mortelle" sont donnés au tableu 2. Le permanganate de potassium fut trouvé comme étant l'un des plus efficaces pour détruire levures et bactéries. L'efficacité fongicide de la poussière de soufre est considérablement augmentée par l'addition en petite proportion de poussière de permanganate.

CURRENT PUBLICATIONS

70. Red Bread. By Maurice Hindus. Published by Jonathon Cape Ltd., London.

Several months ago a review of Humanity Uprooted, by the same author, was published in these columns. It was pointed out in this review that Humanity Uprooted was a very well balanced account of the principles upon which the Russians are building their great experiment. The later book, Red Bread, is an account of how the experiment is working out. The author, born in a little Russian village, returns to his home in 1930 and notes the changes which have taken place. Red Bread describes one of the most amazing developments of human history. Anyone who desires a background for his thinking concerning Russia, cannot afford to overlook these two books by Hindus. One cannot help feel after reading them that although there will be periods of comparative success and failure, the Russian experiment will ultimately succeed. -H.L.T.

71. Commercial Rabbit Breeding Under Australian Conditions. Alfred P. Looker. Available from Dominion Department of Agriculture Library.

The writer deals only with Angoras and Chinchillas for the production of wool and fur, ignoring the meat end of the business, which in Australia may not amount to much but which with us in Canada would be an item worthy of consideration. He points out that it is but recently that the importation of rabbits into Australia was permitted, so that rabbit breeding as an industry is in its infancy. With this in mind, it is apparent that such a treatise will find a decided need in that it gives the novice valuable information on the industry in its various branches as applied to Australian conditions.

General management including selection of stock, the necessity of keeping records, breeding, housing, grooming and shearing, and preparation of pelts are all dealt with. There is also a chapter devoted to diseases and one to the home spinning of Angora wool. This latter is something that has never to our knowledge been practised in America, and might well be given consideration, as there are undoubtedly still many women in rural Quebec, and for that matter in other Canadian provinces who have still retained their cunning at the spinning wheel.

The author's reference to prices of stock reminds one of the old boom days in America when fabulous prices were paid for Belgium hares or of even more recent days when the boom for Chinchillas was at its height.

These high prices may look attractive and something to be striven for by the breeder of high class exhibition stock, but the individual who is taking up rabbit breeding as a commercial proposition for the production of wool, fur or meat, will look askance. However, the little work lives up to what it starts out to be, a short treatise, "to enable the beginner to successfully engage in commercial rabbit breeding in Australia" and as such should be welcomed by novices. -G.R.

72. A Textbook of Agricultural Entomology. By Kenneth M. Smith, D.Sc., Ph.D. 8 vo., 285 pp., 79 illust., Cambridge University Press 12/6. McMillans in Canada.

In his introductory remarks the author stresses the long-standing need in Great Britain for an up-to-date textbook in Agricultural Entomology of a more advanced type than the existing somewhat elementary texts. It is evident that such a book is needed since Curtis' "Farm Insects" published in 1860 still remains the standard of its kind in the British Isles —if somewhat out of date. Apparently British economic entomologists prefer to rely on government and college reports, rather than turn out a mass of elementary textbooks. If the volume in question is any criterion of their ability to produce worthwhile books, then the long wait has not been in vain.

The book consists of 14 chapters, the first three of general interest, the next ten of classification, dealing with insects of economic interest arranged according to Orders, and the last one with insects and virus diseases of crops. Insect pests of fruit have not been included since they are adequately dealt with in Theobald's book.

One feature of the book is the systematic treatment of each insect under a sequence of headings by paragraphs, thus:—Scientific name, Common names; Description of adult,

egg, larva, pupa; Life History; Host plants, cultivated and wild; Symptoms of attack and Injury to host plants; Distribution and affect of Climatic factors; Preventive and Control measures; Natural enemies. Not all these headings are necessarily required for each insect, but the arrangement tends to great clearness.

Another feature is the brief scientific description of each stage of every insect, thus rendering its identification possible by any trained worker, without having to refer to literature or to send the insect to a specialist. Since the author states that the book is intended for the agriculturist and the agricultural entomologist, he presupposes a knowledge of scientific terms and of insect anatomy which would put the plane of the British farmer upon a pleasingly high standard. The list of Natural Enemies named after each insect under consideration, has been compiled with typical thoroughness and shows one of the trends of interest of modern economic entomology.

The final chapter deals briefly and succinctly with "Insects and virus diseases of crops", stressing those of the potato and those diseases which are likely to be brought into Great Britain from the rest of Europe.

Appendix I, giving the "Characteristic symptoms of insect attack", corresponds to the Field Keys of Lochhead and of Flint and Metcalf of this country and summarizes the insects mentioned in the book under the headings of: Crop (the insects arranged according to Orders); Chief symptoms of attack, and Insect attacking.

Appendix II entitled "Common farm weeds in relation to Insect Pests" consists of a list of common farm weeds which act as alternate hosts for many insect pests of agricultural crops, together with the important insects which feed on them.

The book concludes with three thorough Indices, one of Authors, one of Parasites and Predators arranged according to Orders, and a General Index; every reference refers to a page or pages in the text. Moreover, to facilitate reference throughout the book, every page in the first three chapters has the topic printed as the heading of that page and in all succeeding chapters, the Order under discussion is printed on each page. References to literature cited throughout the text are arranged in order to mention at the end of each chapter and are indicated by a tiny numeral in brackets after each name, adequately serving their purpose without detracting from the ease of reading. The 79 illustrations are mostly well-executed drawings, with a few photographs. A greater number of illustrations might be a possible improvement. The book is clearly printed on glazed paper and is strongly bound.

Notwithstanding the fact that the volume purports to be a text for Great Britain, the author has made it of much wider scope, for his references include publications from all over Europe, from South Africa, the United States, Canada, Australia, New Zealand and Nippon. His brief but thorough biological treatment of every insect mentioned is a matter of world-wide rather than purely British interest.

The book is a departure from the somewhat stereotyped "Economic Entomology" of this continent and should occupy an important place on the shelves of every agricultural entomologist. —G.J.S.

73. Agriculture, Climate and Population of the Prairie Provinces of Canada. W. Burton Hurd and T. W. Grindley. Dominion Bureau of Statistics, 50 cents.

This Atlas respresents a statistical summaryof progress in the Prairie Provinces. The material is very largely based upon the Census reports, "with the addition of such supplementary data as are essential to an undersatnding of and distribution of agricultural settlement in the Canadian West. The extent and direction of agricultural expansion have been influenced and in a large measure governed by prevailing physical and economic conditions. The types of farming practised in the region are also related to climate, soil, topography, capital, labour and transportation."

The first part of the Atlas deals with the physical factors. Census data are then used to show the development of agriculture, land utilization, distribution of crops and live stock, farm incomes, expenses, size and tenure of farms and finally a section is devoted to an analysis of the population.

Precipitation maps, pages 13 and 14, a soil map on page 24, and a land utilization map on page 25, are particularly informative. Another on page 46 which shows the value of

stock sold alive and slaughtered and animal products 1925, is also worthy of study, as are those on pages 50, 51, 55 and 56.

Farm facilities are summarized as follows: "In 1926, 18 percent of the farms in the Prairie Provinces reported tractors, 26 reported gasoline engines, 35 percent telephones, 41 percent automobiles or trucks."

A further analysis of live stock and other enterprises along the lines employed in connection with wheat, i.e. the development and shifts in production 1901-1926 and to date, would provide additional data of value. -J.C.

DISCOUNT ON PURCHASE OF MACHINERY

Attention is called to the announcement of one of the large Canadian Implement firms in the front advertising section of this month's issue respecting a ten per cent discount on the purchase of farm machinery and on the balance of accounts owing for the same. This is a move which will undoubtedly be appreciated by farmers in Canada and the company is to be commended on the institution of such a policy. It undoubtedly means some sacrifice to the company and as such it shows their desire to maintain their high standard of service to the Canadian farmer.

NOTICE TO HORTICULTURISTS

The Report of the Committee on Horticultural Education, which was forwarded to the members of the Horticultural Group some time ago, evidently contained a statement which requires some correction. Dean Clement, of the University of British Columbia, has called our attention to the fact that, on the first page, under the heading "Post Graduate", reference is made to the fact that in no Canadian University as yet can work be taken which will give post-graduate standing in horticulture. Dean Clement goes on to point out that post-graduate work in horticulture has been given in the University of British Columbia for some years, the first graduate in horticulture being in 1923, with the degree of M.S.A. in horticulture. There are three students at the University of British Columbuia doing work in horticulture at the present time towards a Master's degree. The work may be taken either in the applied horticultural phases or in fundamental horticultural sciences. It is unfortunate that the above error crept into the Report.

C.S.T.A. MEMBERSHIP FEES

The fiscal year of the C.S.T.A. closes on May 31st. Members who have not yet paid their fees for the current year, June 1, 1931, to May 31, 1932, are urged to do so at once. The General Secretary desires to present to the Directors at the Winnipeg Convention as small a list of members in arrears as possible. Fees received at head office before May 31st will greatly assist in improving the appearance of the balance sheet for this year. Please do not overlook this matter.

CONCERNING THE C.S.T.A.

NOTES AND NEWS

Andrew Skoglund (Manitoba '32) is at present located at the Dominion Range Experimental Station, Manyberries, Alta.

C. Duncan McKenzie (British Columbia '29) has changed his address to 103 Third Avenue, New Westminster, B.C.

Thomas A. Leach (British Columbia '31) has changed his address to Canadian Industries Limited, New Westminster, B.C.

F. F. Baird (Toronto '28), Sheep and Swine Promoter for Prince Edward Island, has been transferred to the Live Stock Branch at Ottawa and his mailing address is Room 569, Confederation Bldg., Ottawa.

J. E. Duchesne (Montreal '21), Instructor in Horticulture and French Secretary of the Quebec Pomological Society, has changed his address to 2632 St. Catherine St., Montreal, P.Q.

J. Albert Hand (Toronto '05), formerly with the United Farmers' Co-operative of Ontario, has joined the Mutual Life of Canada, 320 Bay Street, Toronto. His home address is 366 Glenlake Ave., Toronto, Ont.

Marc H. Hudon (Laval '25) has resigned his position as Technical Advisor of the Chateau Cheese Company, Ottawa, to accept an appointment as a member of the Quebec Dairy Commission under the Quebec Department of Agriculture, Quebec, P.Q.

J. K. Finlayson (Saskatchewan '23), Acting Co-operation and Markets Commissioner of the Saskatchewan Department of Agriculture at Regina, has resigned his position in order to become Secretary of the Regina Board of Trade. He will be succeeded by Mr. B. A. Arnason, who will act as Commissioner during the absence of the Commissioner, Capt. W. Waldron. Mr. Finlayson's address will be 22 Angus Crescent, Regina, Sask.

Dr. A. T. Charron (Ottawa '92, Laval '18), Assistant Deputy Minister of Agriculture for Canada since 1925, is at present acting as Deputy Minister following the resignation of Dr. J. H. Grisdale.

Dr. J. A. Ruddick, (Queen's, '24) Dominion Dairy and Cold Storage Commissioner since 1905, has retired. Dr. Ruddick is a native of Oxford County, Ontario, and at an early age started to learn the dairy business. From practical experience in cheese and butter making he graduated to the position of Instructor for the Eastern Ontario Dairymen's Association and later joined the staff of the Dominion Dairy Commissioner. He was Superintendent of the Eastern Ontario Dairy School from 1894 to 1898 and Dairy Commissioner for New Zealand from 1898 to 1900. He became Chief of the Dominion Dairy Division in 1900. Dr. Ruddick brought to his position a background of long practical experience and has been in the forefront of all movements to better the dairy industry during the last quarter century. Members of the C.S.T.A. join in congratulating him on his long record of faithful service and wish him many years of health and happiness.

WINNIPEG CONVENTION PROGRAMME

The following eight page section of this issue of *Scientific Agriculture* carries the general programme for the Winnipeg Convention of the C.S.T.A. and affiliated organizations and groups. The printing of the programme in the journal is an economy measure. This eight page section has been inserted in such a manner that it may be retained or discarded as preferred by those who are binding their copies. The programme of the C.S.G.A. convention will be found in advertising space on the outside back cover. Complete programmes of the C.S.G.A. convention will be issued at an early date.

Members of the Society who intend to go to Winnipeg and desire accommodation should notify either the General Secretary, 306 Victoria Building, Ottawa, or the Chairman of the Registration Committee, Dr. F. J. Greaney, Dominion Rust Research Laboratory, Winnipeg. No additional programmes will be mailed to members. Further details of hours and places of meeting will be made available at Winnipeg. A splendid programme has been provided and members are urged to attend this convention if at all possible. In addition to the many excellent lectures there is much important business to be transacted.